APPENDIX A

IDENTIFICATION OF COOLING WATER ALTERNATIVES FOR EVALUATION IN THE EIS

A.1 INTRODUCTION

This appendix describes the cooling water alternatives considered for K- and C-Reactors and the D-Area coal-fired powerhouse. It also discusses the process used to identify the cooling water alternatives that are evaluated in this environmental impact statement (EIS).

A.2 INITIAL ALTERNATIVES

As documented in the Thermal Mitigation Study (DOE, 1984), DOE initially considered two categories of cooling water alternatives: (1) those that would provide some reduction in the temperature of thermal discharges but that would not meet the 32.2°C Class B water classification standard of the State of South Carolina; and (2) those that could meet the 32.2°C water classification standard.

A.2.1 ALTERNATIVES NOT MEETING THE 32.2°C STANDARD

For alternatives that would not meet Class B water classification standards (such as rubble dams, small cooling lakes, and the current once-through cooling water systems), the South Carolina legislature and the U.S. Environmental Protection Agency (EPA) would have to approve a new stream classification (i.e., a change in the designation of several onsite streams from Class B to some other classification) after DOE had submitted a use attainability analysis in accordance with EPA regulations (40 CFR 131).

Because of the concern over both the applicability of EPA and State regulations that prohibit designating the use of a stream for waste transport or waste assimilation and the inapplicability of criteria contained in EPA's regulations [40 CFR 131.10(g)] by which a change in designated uses could be justified, DOE eliminated from further consideration those alternatives that would not meet Class B water classification standards.

The following items describe the initial cooling water alternatives for K- and C-Reactors that were eliminated:

- Spray canals. This alternative would add a gravity-powered spray cooling system to the cooling water outlets of K- and C-Reactors to cool the discharged water by spraying it into the air before it enters the receiving water body. Both the 68°C maximum discharge temperature and the 66°C average summer temperature would be only slightly below the water temperatures that result from direct discharge (i.e., 73°C and 71°C, respectively).

- Small lakes. This system would use five to ten small rubble dams each on Four Mile Creek and Pen Branch to create small lakes; it would provide some thermal mitigation, compared to direct discharge, to the lower portions of these waterways and to the Savannah River swamp. Under extreme summer conditions, the 45°C discharge temperatures would represent a 28°C reduction below direct discharge (73°C), but they would not meet the 32.2°C temperature standard at any time during the year.

- Small lakes with upstream spray cooling (one set). This alternative is very similar to the small lakes alternative (above), but would include a gravity spray module in the outfall canal. It would result in some limited thermal mitigation in comparison to direct discharge, but would not provide much more cooling than the small lakes alternative alone. The 32.2°C water classification standard would not be met at any time during the year.

- Small lakes with upstream and downstream spray cooling (two sets). This alternative would add two gravity spray cooling modules to the basic small lakes alternative described above. The first spray system would obtain some cooling before the discharge water enters the receiving water body. The second spray module would be in the last shallow lake formed in either stream. The cooling from this system would be about 5°C greater than that resulting from the small lakes with upstream spray cooling (one set) described above. In comparison to direct discharge, this alternative would reduce water temperatures from 73°C to 39°C under extreme summer conditions and from 69°C to 34°C during the spring. It would be in compliance with the 32.2°C temperature limit only during the winter (29°C).

- Energy recovery systems. The systems that were considered included both onsite steam generation and the use of a Rankine cycle to generate electricity. The option of onsite steam generation would remove only 0.3 percent of the heat from the effluent stream, or a 0.3°C drop in effluent temperature at the outfall. The Rankine cycle would lower the effluent temperature from 71°C to 49°C. (See Appendix I for details.)

A.2.2 ALTERNATIVES MEETING THE 32.2°C STANDARD

For those alternatives that could meet the Class B water classification standards, DOE identified subcategories of potential generic cooling water systems for K- and C-Reactors and for the D-Area coal-fired powerhouse. The subcategories identified for K- and C-Reactors consisted of cooling towers, cooling lakes and ponds, and cooling lake/pond and cooling tower combinations. For the D-Area powerhouse, the subcategories included cooling towers, direct discharge to the Savannah River, and increased flow with mixing. DOE then developed minimum requirements for the identification in more detail of the specific alternatives in each subcategory. These requirements included sufficient surface area in cooling lakes or ponds for heat dissipation, and sufficient cooling capacity in once-through and recirculating cooling towers to attain a 32.2°C discharge temperature during extreme meteorological conditions.

Using these minimum requirements, DOE initially identified 22 potential cooling water alternatives for K- and C-Reactors and four alternatives for D-Area. The following list describes these alternatives:

K-Reactor Alternatives

K-1 1400-acre once-through cooling lake between Pen Branch and Four Mile Creek above the railroad track

K-2 1400-acre recirculating cooling lake between Pen Branch and Four Mile Creek above the railroad track

K-3 1300-acre once-through cooling lake on Pen Branch with an embankment 1219 meters below Road C

K-4 1300-acre recirculating cooling lake on Pen Branch with an embankment 914 meters below Road C

K-5 Recirculating cooling tower TC

K-6 Once-through cooling tower

K-7 Once-through cooling tower to a 600-acre once-through cooling lake on Indian Grave Branch with an embankment about 305 meters above the confluence with Pen Branch

K-8 800-acre cooling lake with a 400-acre hot arm to a once-through cooling tower with an embankment located about 610 meters above Road A on Pen Branch

K-9 1600-acre once-through cooling lake with an embankment in the same location as the 800-acre lake with 400-acre hot arm (above)

K-10 1700-acre once-through cooling lake on Pen Branch with an embankment about 2134 meters below Road C, and the reactor discharge pumped to the cooling lake

C-Reactor Alternatives

C-1 1200-acre once-through cooling lake on Four Mile Creek with an embankment about 1.6 kilometer above Road A

C-2 1200-acre recirculating cooling lake on Four Mile Creek with an embankment about 1.6 kilometer above Road A

C-3 1400-acre once-through cooling lake between Pen Branch and Four Mile Creek below the railroad track

C-4 Recirculating cooling tower TC

C-5 Once-through cooling tower

C-6 Once-through cooling tower to a 500-acre once-through cooling lake on a tributary of Four Mile Creek with an embankment about 305 meters above the confluence with Four Mile Creek

C-7 800-acre cooling lake with a 400-acre hot arm to a once-through cooling tower with an embankment on Four Mile Creek about 1280 meters above Road A

C-8 1700-acre once-through cooling lake on Four Mile Creek with an embankment about 1280 meters above Road A

C-9 1700-acre once-through cooling lake on Four Mile Creek with an embankment about 152 meters above Road 4, and the reactor discharge pumped to the cooling lake

K- and C-Reactors Alternatives

K/C-1 3000-acre recirculating cooling lake on Mill Creek with an embankment about 610 meters above the confluence with Tinker Creek

K/C-2 3000-acre once-through cooling lake on Mill Creek with an embankment about 610 meters above the confluence with Tinker Creek

K-, C-, and L-Reactors Alternatives

K/C/L-1 3000-acre once-through and recirculating cooling lake on Mill Creek with an embankment about 610 meters above the confluence with Tinker Creek

D-Area Powerhouse Alternatives

D-1 Direct discharge to the Savannah River
D-2 Once-through cooling tower
D-3 Increased flow with mixing
D-4 Recirculating cooling tower

A.3 SCREENING OF ALTERNATIVES

After the identification of the 26 cooling water alternatives that could meet Class B water classification standards, DOE used a screening process to determine which of these systems would be the most reasonable for implementation.

As documented in the Thermal Mitigation Study, the screening process consisted of the successive application of exclusionary criteria and discriminatory criteria. The application of "exclusionary" criteria led to the elimination of five cooling-lake alternatives for K- and C-Reactors. The "exclusionary" criteria are listed below:

1. The temperature of the receiving stream shall not exceed 32.2°C after mixing unless a Section 316(a) demonstration can be successfully performed.

2. The temperature of a receiving stream shall not be raised more than 2.8°C above ambient after mixing unless a Section 316(a) demonstration can be successfully performed.

3. Cooling lakes shall have a minimum surface area of 400 acres at a temperature of 32.2°C or less to support a successful Section 316(a) demonstration.

4. The average annual production loss shall be equal to or less than 10 percent for the purpose of screening.

This screening step eliminated the following alternatives:

No.	Alternative	Reasons for elimination
		K-Reactor
K-2	1400-acre recirculating cooling lake	Too small to provide needed cooling capacity
K-4	1300-acre recirculating cooling lake	Too small to provide needed cooling capacity
K-9	1600-acre once-through cooling lake	Hot arm of about 500 acres would not provide required cooling capacity
		C-Reactor
C-2	1200-acre recirculating cooling lake	Too small to provide needed cooling capacity
C-8	1700-acre once-through cooling lake	Hot arm of about 500 acres would not provide required cooling capacity

DOE screened the possible alternatives for the D-Area coal-fired powerhouse in the same manner as that used for the two reactors. However, it did not apply the criteria for maintaining a surface area of 400 acres at 32.2°C or less. The process found all four of the possible alternatives for the powerhouse to be feasible and eliminated none at this point.

The final step in the screening process was the application of the five "discriminatory" criteria listed below to identify "reasonable compliance alternatives":

1. Environmental impacts (i.e., thermal and flow effects resulting from the effluent discharge; habitat modifications such as impacts to wetlands and uplands; water quality; intake/discharge rates; impingement and entrainment; impacts to endangered and threatened species; and transport of radionuclides)

2. Implementation schedule (i.e., the estimated time to construct the alternative)

3. Costs (capital and operating)

4. Engineering and construction (i.e., the technical feasibility of engineering and constructing the alternative, such as pumping hot water over long distances, close approaches to wet bulb temperatures, nonstandard engineering and construction techniques)

5. Relative operating complexity (i.e., multiple reactor cooling systems versus recirculation systems versus once-through systems)

After the application of the discriminatory criteria, DOE eliminated the following nine alternatives:

No.	Alternative	Reasons for elimination
		K-Reactor
K-3	1300-acre once-through cooling lake	Environmental impacts, production loss, relative costs
K-10	1700-acre once-through cooling lake	Environmental impacts, relative costs, scheduling
		C-Reactor
C-1	1200-acre once-through cooling lake	Environmental impacts, production loss, relative costs
C-9	1700-acre once-through cooling lake	Environmental impacts, relative costs, scheduling
		K- and C-Reactors Combined
K/C-1	3000-acre recirculating cooling lake	Relative costs, production loss, operating complexity, engineering considerations
K/C-2	3000-acre once-through cooling lake	Environmental impacts, operating complexity, relative costs
		K-, C-, and L-Reactors Combined
K/C/L-1	3000-acre once-through and recirculating cooling lake	Operating complexity, scheduling

No.	Alternative	Reasons for elimination
	D-Area Powerhouse	
D-2	Once-through cooling tower	Relative costs, operating complexity compared to direct discharge
D-4	Recirculating cooling tower	Relative costs, operating complexity compared to direct discharge

As a result of the successive application of the exclusionary and discriminatory criteria, DOE identified the following alternatives as reasonable for implementation for K- and C-Reactors and the D-Area coal-fired powerhouse:

K-Reactor Alternatives

K-1 1400-acre once-through cooling lake between Pen Branch and Four Mile Creek above the railroad track

K-5 Recirculating cooling tower TC

K-6 Once-through cooling tower

K-7 Once-through cooling tower to a 600-acre once-through cooling lake on Indian Grave Branch with an embankment about 305 meters above the confluence with Pen Branch

K-8 800-acre cooling lake with a 400-acre hot arm to a once-through cooling tower with an embankment located about 610 meters above Road A on Pen Branch

C-Reactor Alternatives

C-3 1400-acre once-through cooling lake between Pen Branch and Four Mile Creek below the railroad track

C-4 Recirculating cooling tower TC

C-5 Once-through cooling tower

C-6 Once-through cooling tower to a 500-acre once-through cooling lake on a tributary of Four Mile Creek with an embankment about 305 meters above the confluence with Four Mile Creek

C-7 800-acre cooling lake with a 400-acre hot arm to a once-through cooling tower with an embankment on Four Mile Creek about 1280 meters above Road A

D-Area Powerhouse Alternatives

D-1 Direct discharge to the Savannah River

D-2 Increased flow with mixing

A.4 ALTERNATIVES CONSIDERED IN THIS EIS

As part of the scoping process, DOE invited interested parties to comment on the alternatives it would consider in this environmental impact statement (Federal Register, 50 FR 30728). Because of unfavorable topographic features in the areas around K- and C-Reactors and the resulting high capital costs for constructing large cooling lakes, DOE proposed that this statement consider only the once-through and recirculating cooling towers. In addition, DOE proposed that it not perform a detailed evaluation of the alternative calling for direct discharge of D-Area effluents to the Savannah River because of its higher capital costs, the longer schedule for implementation, and the potential reduction in habitat for endangered species that would be caused by the reduction in flow in Beaver Dam Creek. During the scoping period, DOE received no comments related to its preliminary determination of reasonable alternatives to be considered in the environmental impact statement.

Based on the screening process as documented in the Thermal Mitigation Study (DOE, 1984) and DOE's preliminary determination (50 FR 30728), DOE has decided to consider in detail in this environmental impact statement the alternatives of once-through and recirculating cooling towers for the K- and C-Reactors in addition to the "no-action" alternative (required by the Council on Environmental Quality for implementing the procedural provisions of the National Environmental Policy Act). For the D-Area coal-fired powerhouse, the Department has decided to consider in detail the alternatives of increased pumping to the raw water basin, direct discharge to the Savannah River, and "no action."

AD-1 Since the completion of the Thermal Mitigation Study and the Draft EIS (DOE,
1986), further design evaluations and studies have been initiated to determine
AD-2 optimal performance parameters and to achieve lower costs. These evaluations
and studies have indicated that, in several areas, optimization of performance
BB-1 and cost savings can be realized in the construction and operation of once-
BB-2 through towers without introducing major changes in the nature or magnitude of
the environmental impacts. These areas include the consideration of gravity-
BB-3 feed versus pumped-feed towers, natural-draft versus mechanical-draft towers,
BC-4 and a chemical injection system for either dissipation or neutralization of
chlorine biocide versus holding ponds (and their sizing). Similarly, these
BC-5 evaluations and studies have also led to the development of thermal perform-
BC-6 ance criteria that, when incorporated in the final design of a once-through
cooling-tower system, would reduce the potential for cold shock (i.e., reduce
BC-14 the difference between ambient stream temperatures and stream temperatures
BD-1 when the cooling water is being discharged) to fish.

REFERENCES

DOE (U.S. Department of Energy), 1984. Thermal Mitigation Study, Compliance with Federal and South Carolina Water Quality Standards, Savannah River Plant, Aiken, South Carolina, DOE/SR-5003, Savannah River Operations Office, Aiken, South Carolina.

TC

DOE (U.S. Department of Energy), 1986. Draft Environmental Impact Statement, Alternative Cooling Water Systems, Savannah River Plant, Aiken, South Carolina, DOE/EIS-0121D, Savannah River Operations Office, Aiken, South Carolina.